



# Spot and Runway Departure Advisor (SARDA)



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# Topography of Airport and Surface Management



- 8 major airports – over \$2B of excess fuel consumption over 2010 – 2030
- JFK – 15,000 hours of taxi delays per year
- BOS – 6,570 hours of taxi delays per year



Surface traffic management complicated by:

- Uncertainties
- Lack of common situational awareness and coordination
- First-come, first served operations

# Intelligent Scheduling is the Key to Efficient Surface Management

SARDA is the NASA's approach for solving this problem.

- Optimizes at a system level by minimizing overall delay
- Plans at a detailed trajectory level for aircraft movement (gate, ramp, taxiways, and runways)
- Uses a fast algorithm suited to real-time operations
- Accounts for departures and arrivals
- Connects the airport tower, en route facility, and the airlines
- Adaptable to other airports with different configurations

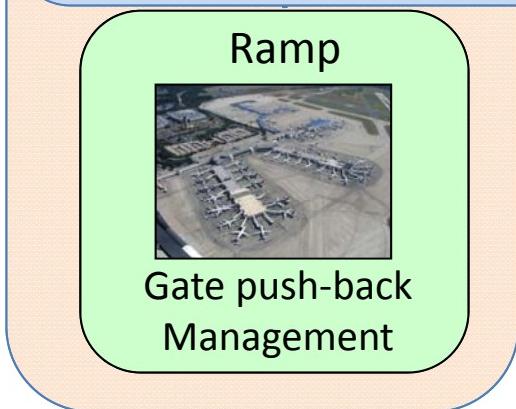
# SARDA Concept



- Runway sequence & time



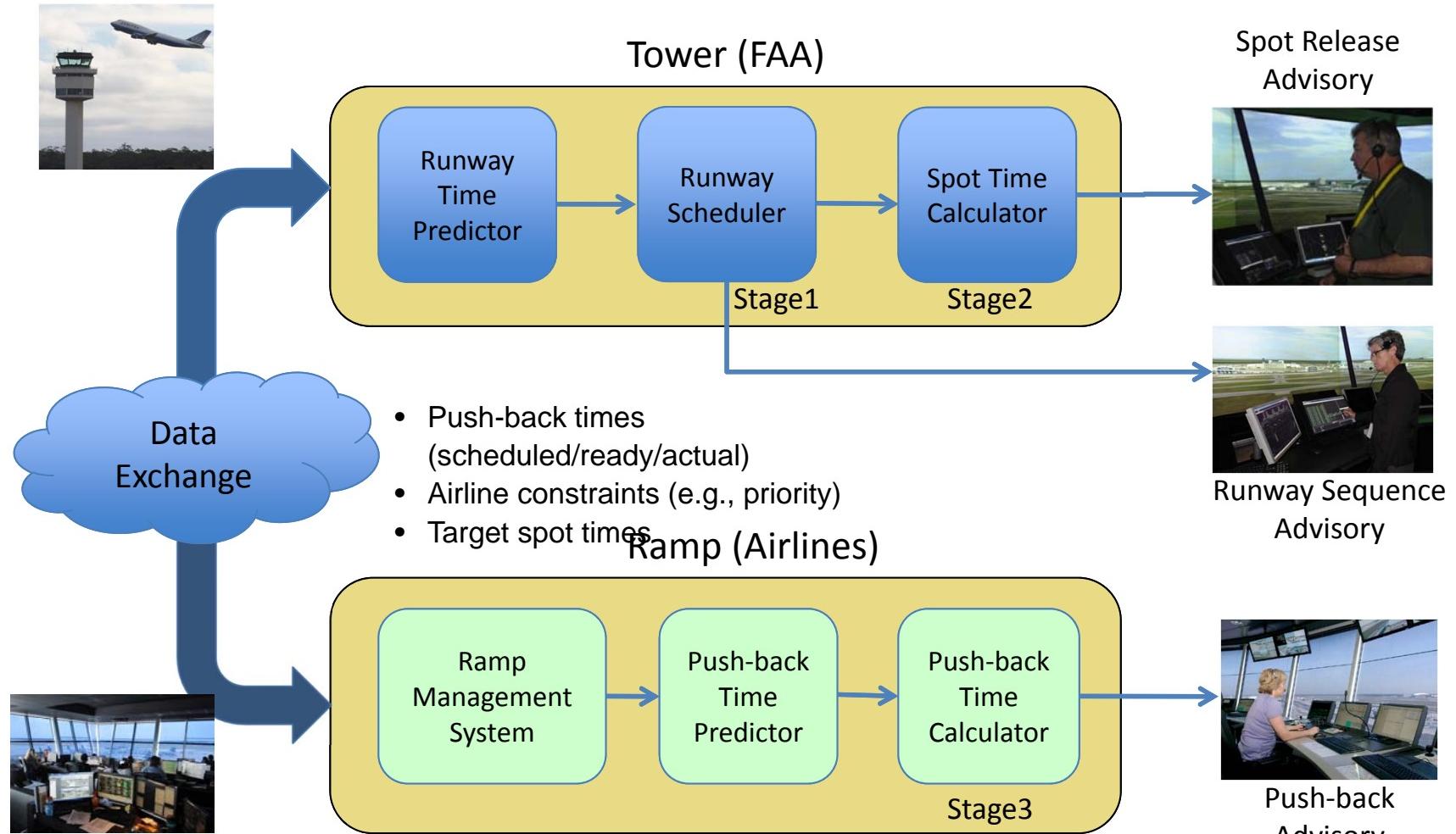
- Reduce taxi delay
- Reduce fuel consumption and emissions/noise
- Increase predictability



Gate push-back  
Management



# SARDA Scheduler Methodology

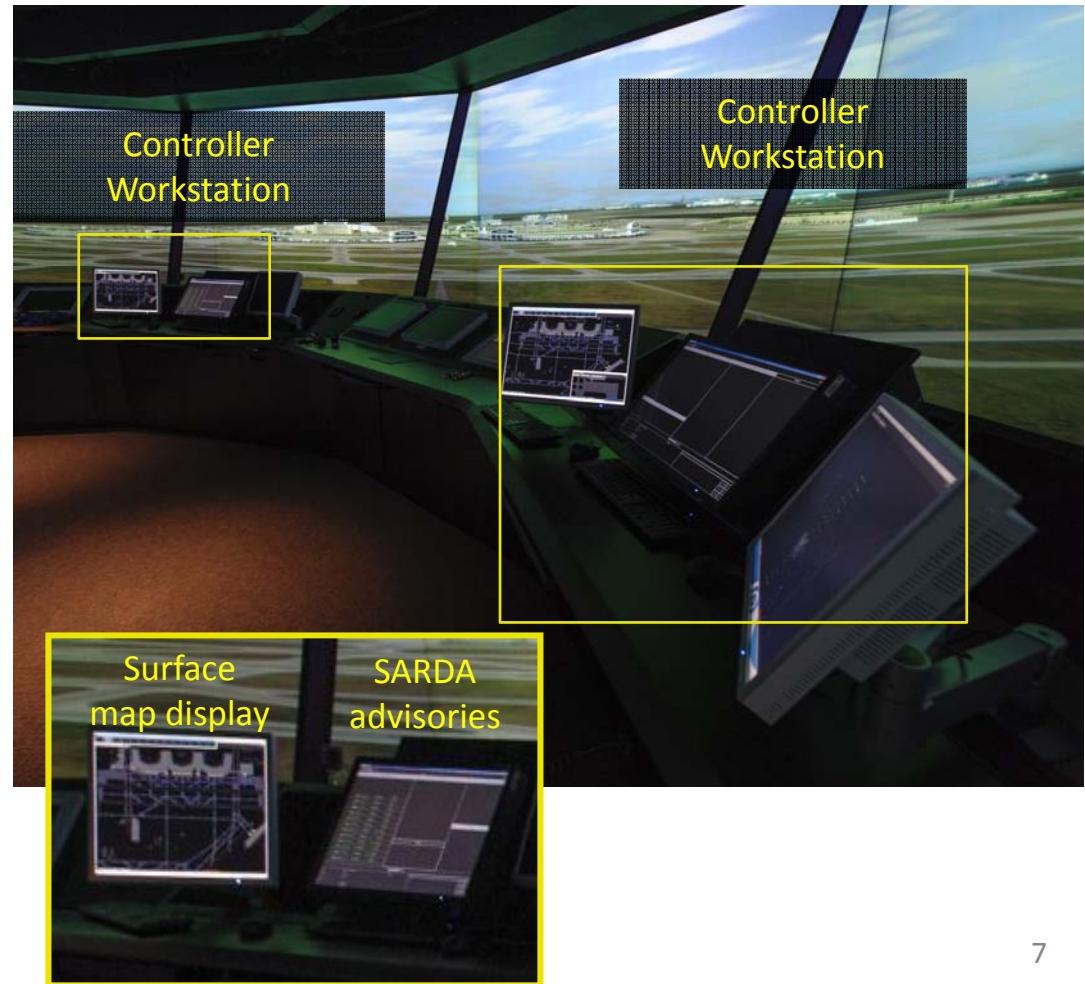


**Handles uncertainties by frequent updates and freezing sequence for spot release and takeoffs/crossings**

# Recent Results

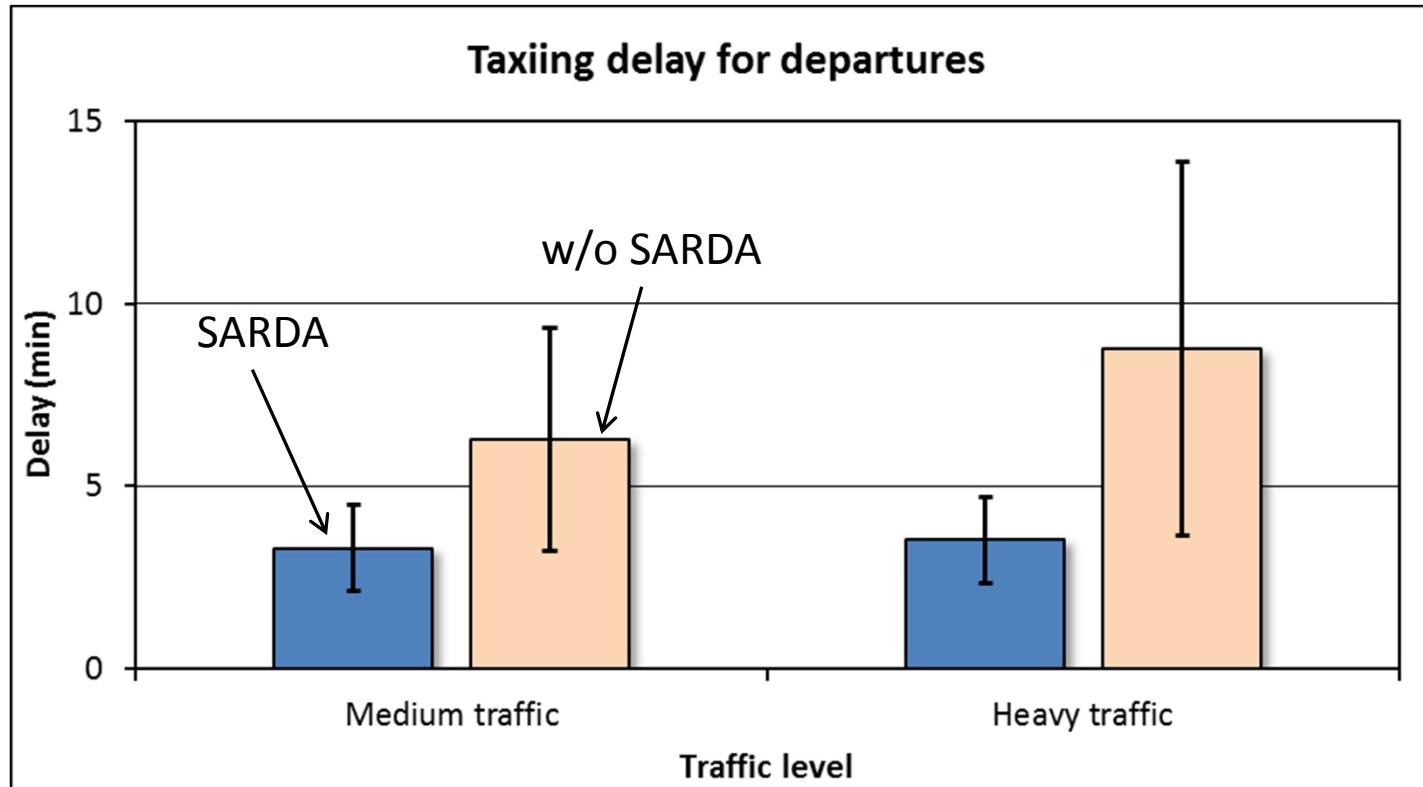
# SARDA HITL Simulation

- Two major simulations for DFW (2010, 2012)
- DFW experienced controllers
- Data collected on performance and controllers workload



# Taxiing Delay for Departures

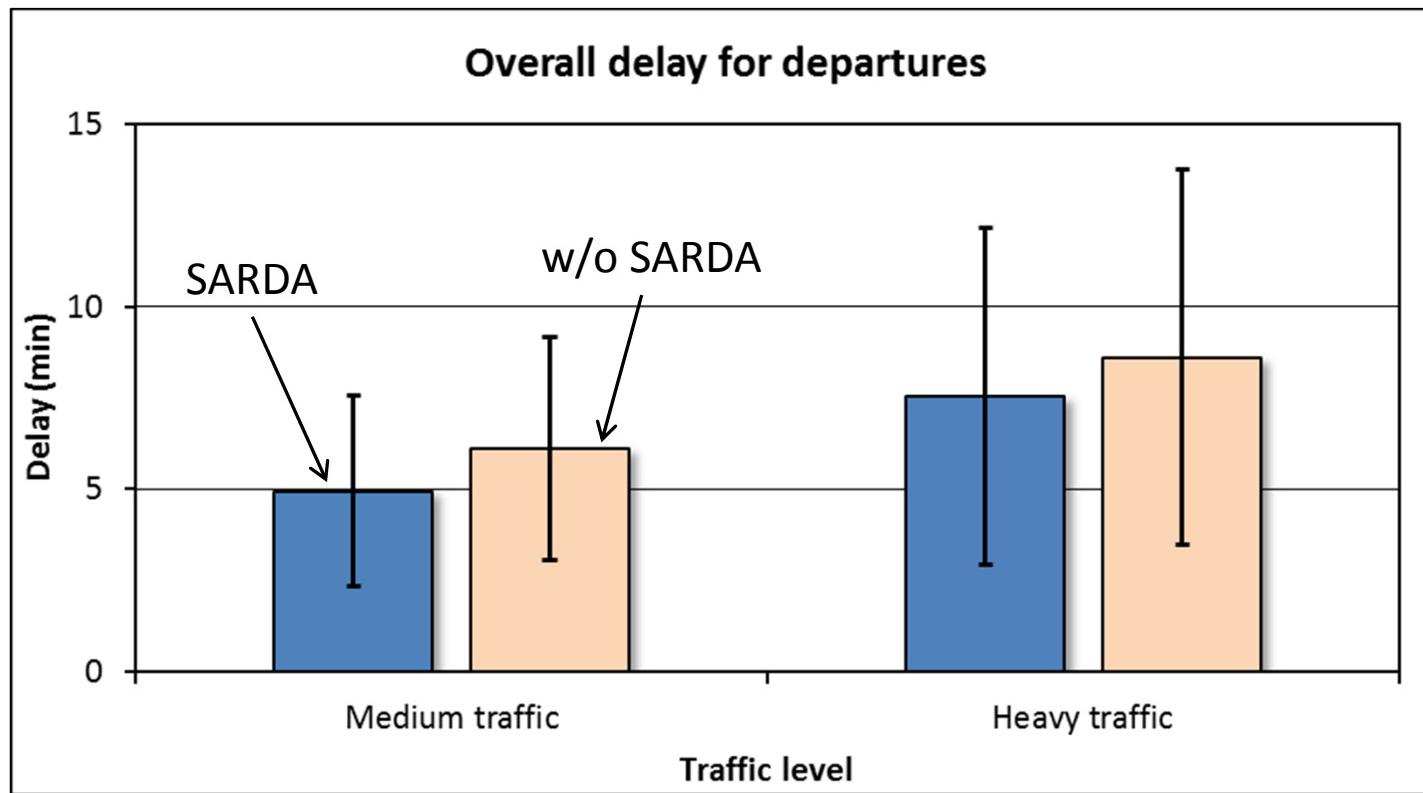
(Actual taxi time – Unimpeded Taxi Time)



- Observed reduction in taxiing delay statistically significant
- Reduction in mean as well as variance
- Reduction in variability and increase in predictability

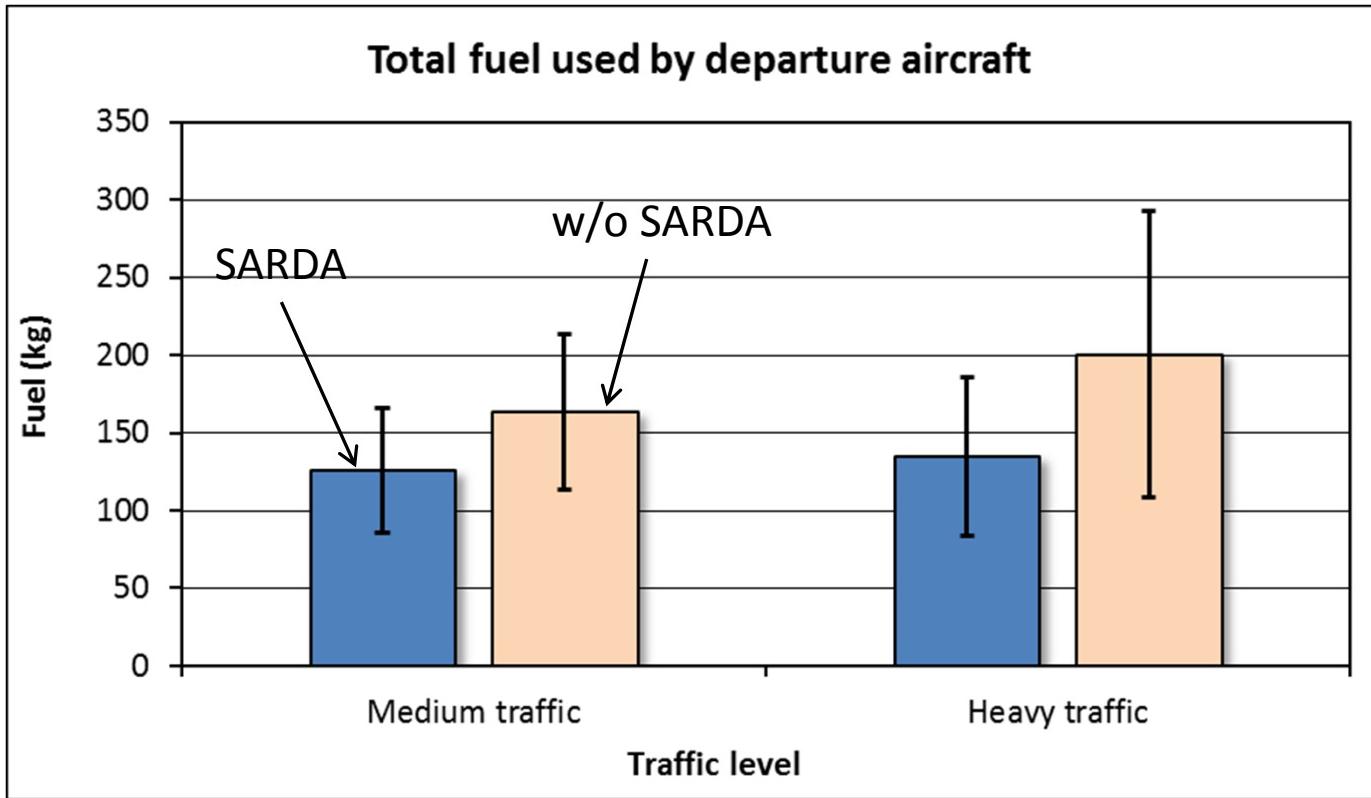
# Overall Delay

(Actual Takeoff Time – Scheduled Takeoff Time)



- SARDA resulted in statistically significant reduction in overall delay ( $p \sim 0.02$ )
- Overall system delay reduced by an average of 1 minute per aircraft

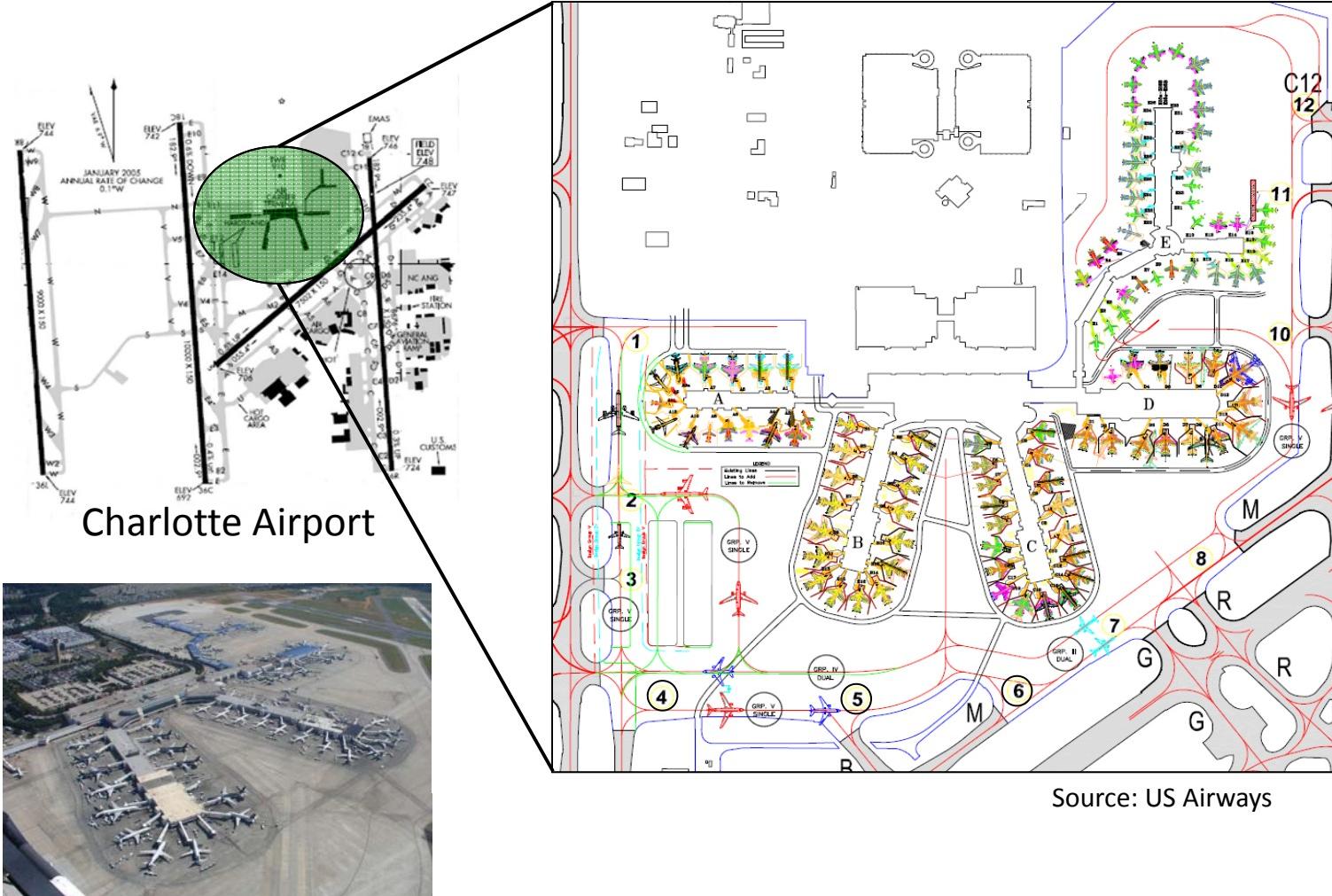
# Departure Taxi Fuel Consumption



- Observed reduction in fuel consumption: 23% average reduction in medium traffic and 33% average reduction in heavy
- SARDA reduces variability in fuel consumption

# SARDA for CLT Ramp Operations

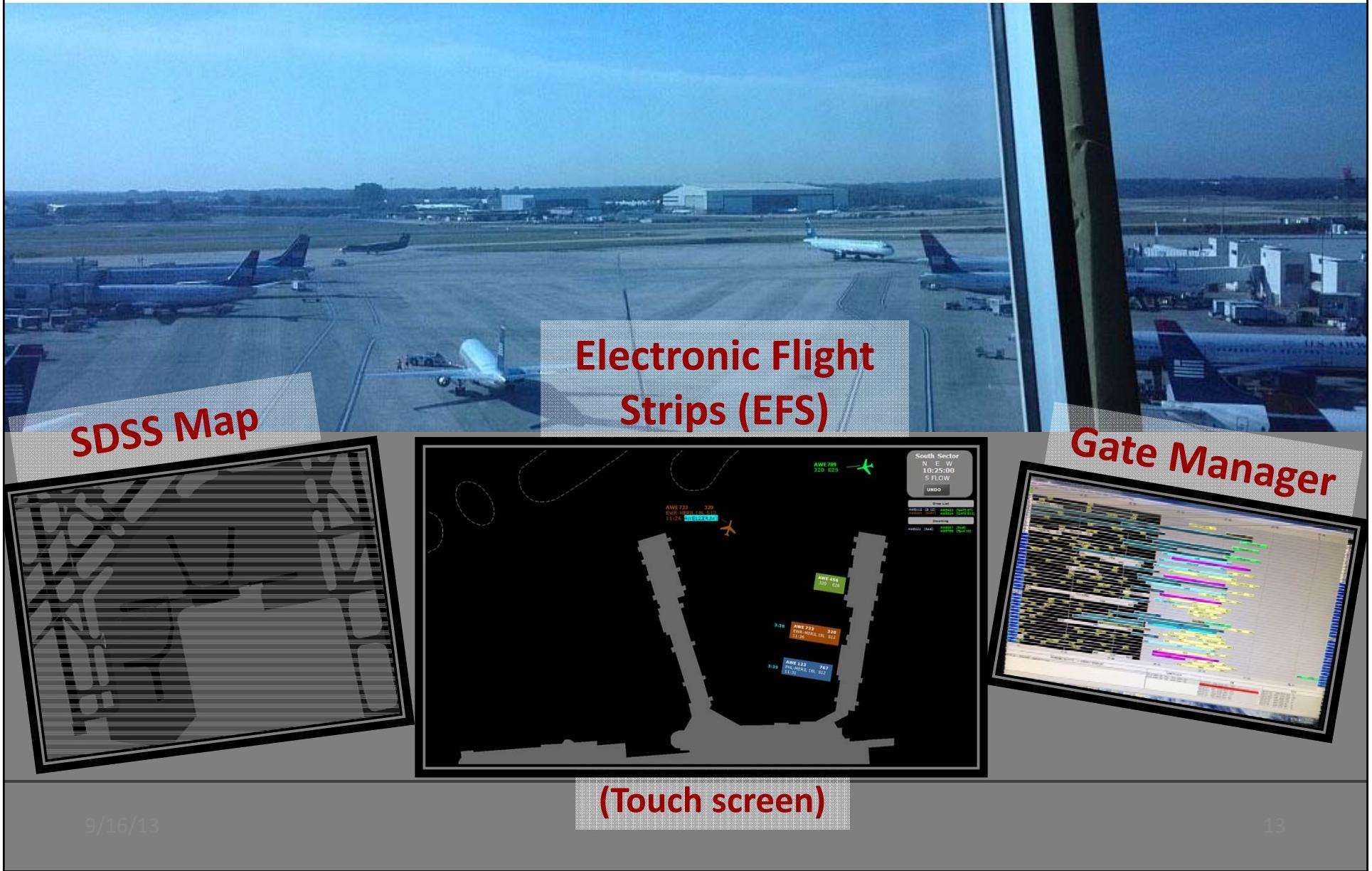
# Charlotte Airport Field Testing (2015)



9/16/13

12

# Ramp Sector Controller Workstation (Illustration Purpose Only)



# US Airways-NASA Collaboration

- Goal - To develop and test a prototype DST for US Airways CLT ramp controllers for efficiency enhancement
- HITL simulations in three phases:
  - Phase 1: Building/testing core functions
  - Phase 2: Benchmark test
  - Phase 3: Follow-on tests
- Target dates:
  - Oct 2013              Completion of first HITL simulation
  - Aug 2014              Completion of benchmark test
  - Oct 2014              Completion of system integration at US Airways ramp tower
  - Sept 2015              Completion of field tests

# Collaboration with DLR and NLR

# NASA-DLR Collaboration

- NASA's expertise
  - Surface decision support tool (e.g., SARDA)
  - Fast-time simulation and human-in-the-loop simulation capabilities
  - Flight deck based research on taxi conformance and trajectory-based surface operations
- DLR's expertise
  - Research prototype of taxi management (e.g., Taxi Routing of Aircraft: Creation and Controlling (TRACC))
  - Arrival/departure management tools (AMAN/DMAN) and coordination
- Collaboration tasks
  - Compare surface management concepts between DLR and NASA
  - Develop a common integrated surface concept of operations
  - Evaluate DLR and NASA surface tools/algorithms in the other's environment:
    - DLR models a US airport for testing TRACC
    - NASA models a German airport for testing NASA surface algorithm



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Ground Controller Advisories by SARDA  
(Dallas/Ft. Worth Airport)



TRACC (Hamburg): a taxi route of a departure aircraft shown with speed advisories

# NASA-NLR Collaboration

- Goal: Integrate NLR's taxiway movement conflict detection technology with SARDA for a selected US Airport and conduct a HITL at NASA's FFC.
- NASA technology – SARDA and high-fidelity HITL simulation
- NLR technology – Virtual Block Control (VBC) and Separation Bubbles (SBT)
- Collaboration tasks
  - Model a US Airport in NLR's simulation environment and implement VBC in low visibility condition
  - Integrate NLR's SBT in NASA's Surface Management System (SMS)
  - Conduct HITL simulations at FFC and shadow mode tests

# Questions?